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DETECTION OF OBSTRUCTIONS IN VENOUS BLOOD FLOW

AGAHI, A., WARD, P., KERNOHAN, W.G. MOLLAN, R.A.B.
Department of Orthopaedic Surgery
The Queen's University of Belfast
Musgrave Park Hospital
Stockman's Lane
Belfast, BT9 7JB.

Following any surgical procedure on an anaesthetised patient, there is a significant risk of a blood clot forming within the venous system. This is known as a "Deep Venous Thrombosis" or D.V.T. If part of this clot breaks free, it can lodge in a major lung vessel with potentially lethal consequences. This problem is one that encompasses all branches of surgery, especially orthopaedic surgery, which is our area of concern. patients undergoing a total hip replacement, face an increased risk by virtue of their age and nature of surgery.

The detection or diagnosis of a D.V.T. is notoriously difficult. Clinical signs of swelling, tenderness, pain on walking, localised increases in temperature, and Homan's sign, are of little discriminatory value. It has been estimated that 50% of patients with calf vein thrombosis have no clinical signs, and that 50% of patients with clinical signs of a D.V.T. have normal deep veins. It is therefore obvious that the consideration of clinical signs is not sufficient.

The present methods of diagnosis may be divided into two categories, namely invasive and non-invasive. Invasive methods include radio-active labelled fibrinogen test, and venography, which, although reasonably reliable in comparison with other methods, have the associated problems of irritation to the venous system, pain at the injection site, and the possibility of infection.

Non-invasive techniques, our main area of interest, presently face the problem of unreliability. It has been our principal concern to investigate this area, with a view to the improvement of present techniques by the application of new technology, or the introduction of new methods bearing the qualities of reliability, accuracy, and simplicity for routine use.

Impedance Plethysmography, I.P.G., probably the best known non-invasive method, is reasonably accurate in detecting certain types of D.V.T's, but falls short in others. It uses the principle that the presence of a blood clot in the veins will obstruct blood flow in those veins. This is detected by resisting blood outflow from the calf deep venous system for a short period of time (approximately 30 sec), and then removing the restriction, noting the volume drop and hence blood outflow in the immediate 3 second interval. It is reasonable to assume that the volume drop in this 3 second interval is a direct reflection of the freedom of blood flow.

Although this technique seems appropriate, and indeed ingenious, the I.P.G. can be criticised for the indirect method it uses to detect the volume of blood in the calf muscle: The impedance across the calf muscle is taken to be a measure of the blood volume in the muscle. Our addition to this field uses the above principle, but concentrates on a more direct method of measuring the volume of blood in the calf muscle.

The Volume Plethysmograph (V.P.G.), uses a transducer that is attached around the calf muscle, conforming to the shape of the calf. Made of a thin layer of elastic material, this transducer is electrically isolated from the human body, and responds with high sensitivity to the change in volume of the muscle. Operation of the V.P.G. consists of four steps:

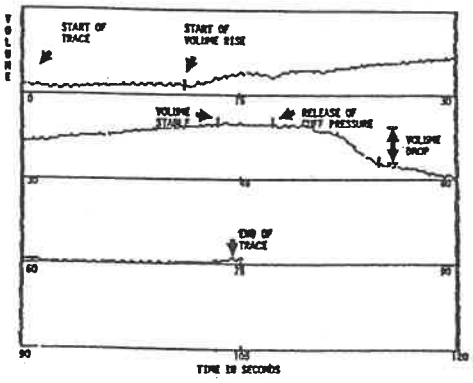
1 An inflatable cuff is positioned around the thigh

2 The cuff is inflated to a pre-determined pressure in order to restrict venous outflow.

3 The pressure is maintained until the change in volume of the calf muscle stabilises.

4 The pressure is released.

The information is recorded by a computer and displayed on a screen, in the form of a trace of volume versus time, as shown in the figure. The useful information is extracted from these results and compared with established results. The two important factors are:



THIS FIGURE SHOWS THE COMPUTER SCREEN DIVIDED INTO FOUR, REPRESENTING ONE CONTINUOUS TRACE

(a) The volume rise during steps 2 and 3 above

(b) The volume drop in a pre-determined interval immediately following step 4 above.

The comparison is done by the computer, the results are displayed, and a diagnosis suggested.

It is hoped that this addition will, in the course of time, contribute to the accuracy, and eliminate the unreliability, of non-invasive methods of D.V.T. detection.